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# Thermal Analysis Using Assembly FEMs in Teamcenter, NX and Space Systems Thermal

by

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# Thermal Analysis within Teamcenter



- 
- You can work within Teamcenter to perform an orbital thermal analysis of a spacecraft.
  - Use existing NX parts and assemblies.
  - Create FEMs and Sims directly off of the parts in Teamcenter.
  - Create assembly FEMs to match the assembly parts.
  - Map part FEMs onto the assembly FEMs.
  - Import thermal couplings and loads from the lower level Sims.
  - Define and display orbits.
  - Solve in Space Systems Thermal.



# Start with Teamcenter



The screenshot shows the Teamcenter 8 interface. The title bar reads "My Teamcenter - Teamcenter 8". The menu bar includes File, Edit, View, Tools, Window, and Help. The toolbar contains various icons for file operations. The main window is titled "My Teamcenter (Krylo, Robert (rkrylo) - EngAnalysis / Thermal [JPL-PRD])". The left sidebar has a "Search" section with a text input "Enter Item ID to search" and a "Quick Links" section with links to Home, My Worklist, My Projects, My Links, and My Saved Searches. Below this is an "Open Items" section with a "Close All" button and a list of items including "Checked-Out Objects (3)", "Checked-Out Objects (2)", "Checked-Out Objects (1)", "rjk\_SWOT\_10m\_baseline\_assysim", and "Home". At the bottom of the sidebar is a "History" section and a "Favorites" section with an "Organize" button. The main content area is divided into two panes. The left pane shows a tree view of the "Home" directory with subfolders: Mailbox, Newstuff, Library, Markup folder, SWOT, Junk, Baseline, 10m, Jason-3, Test materials-suffix, and My Saved Searches. The right pane shows a table of objects with columns: Object, Type, Relation, Own..., Grou..., and Date. The table contains the following data:

Object	Type	Relation	Own...	Grou...	Date
Mailbox	Mail Folder	Contents	Kryl...	Inac...	21-M
Newstuff	Newstuff Fo...	Contents	Kryl...	Inac...	16-D
Library	Folder	Contents	info...	dba	30-A
Markup folder	Folder	Contents	Kryl...	Eng...	05-M
SWOT	Folder	Contents	Kryl...	Eng...	27-J
Jason-3	Folder	Contents	Kryl...	Eng...	30-A
Test materials-suffix	Item	Contents	Kryl...	Eng...	28-S
My Saved Searches	Folder	Contents	Kryl...	Eng...	13-A

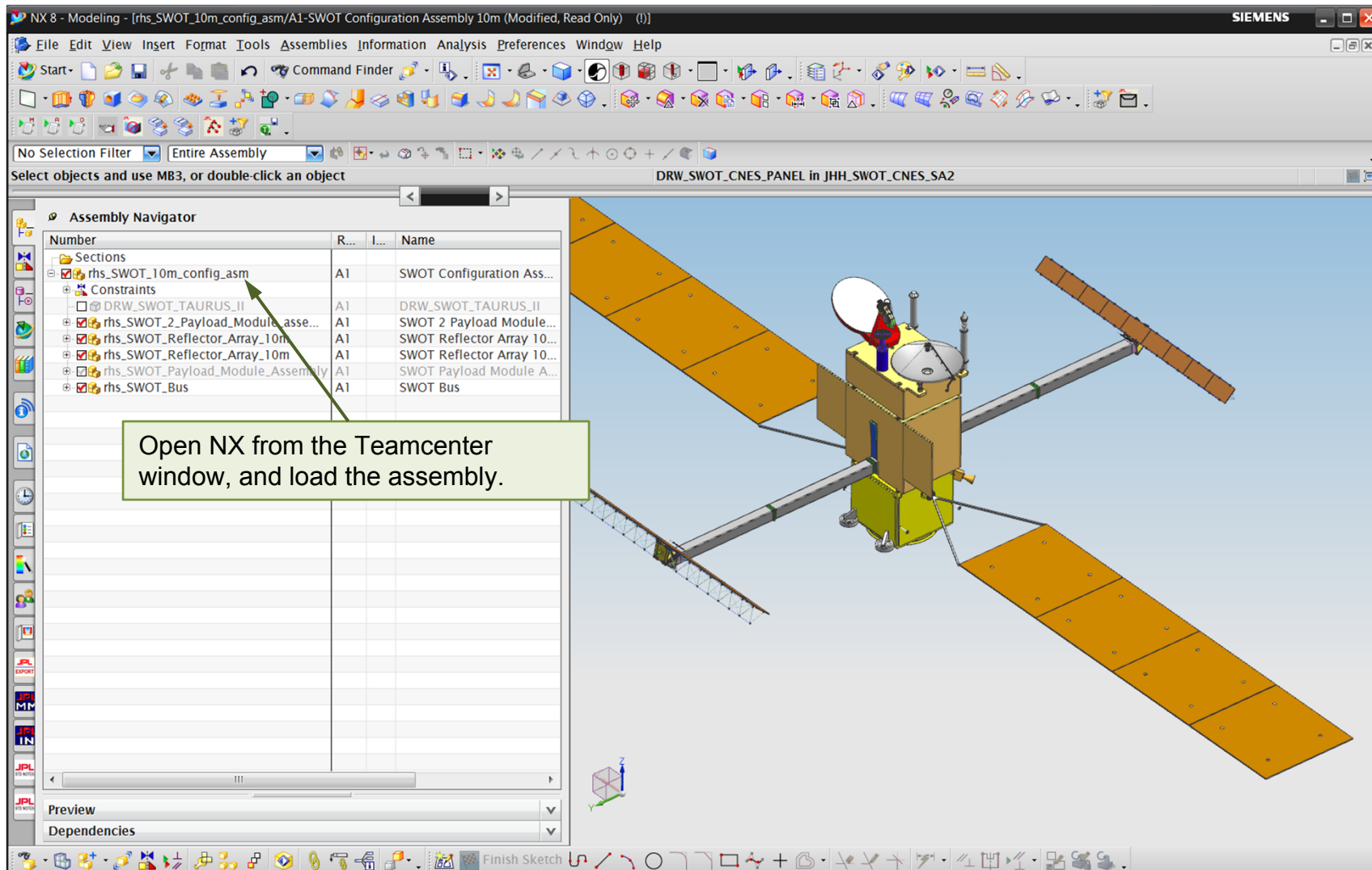
Below the table is a "Search Results" section. A green text box is overlaid on the bottom right of the interface, containing the following text:

Start with a spacecraft, available as an NX assembly in Teamcenter. You can build your thermal model directly on the NX parts so the model will be associative, modular, accessible to other thermal engineers, and under the configuration control of Teamcenter.

To begin:  
Open Teamcenter and create a directory for your files.



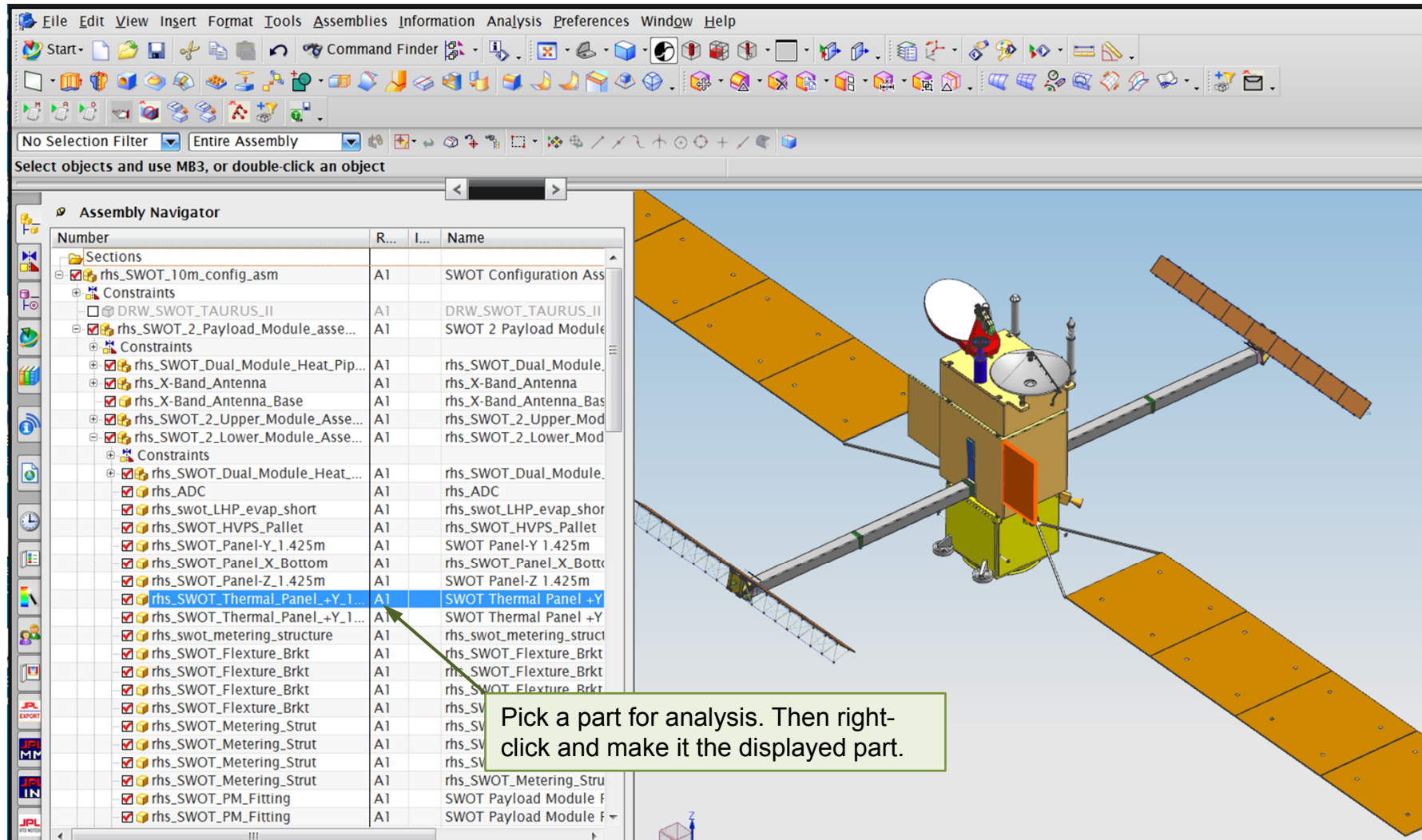
# Open NX and the Assembly







# Select a Part





# Create a FEM and SIM



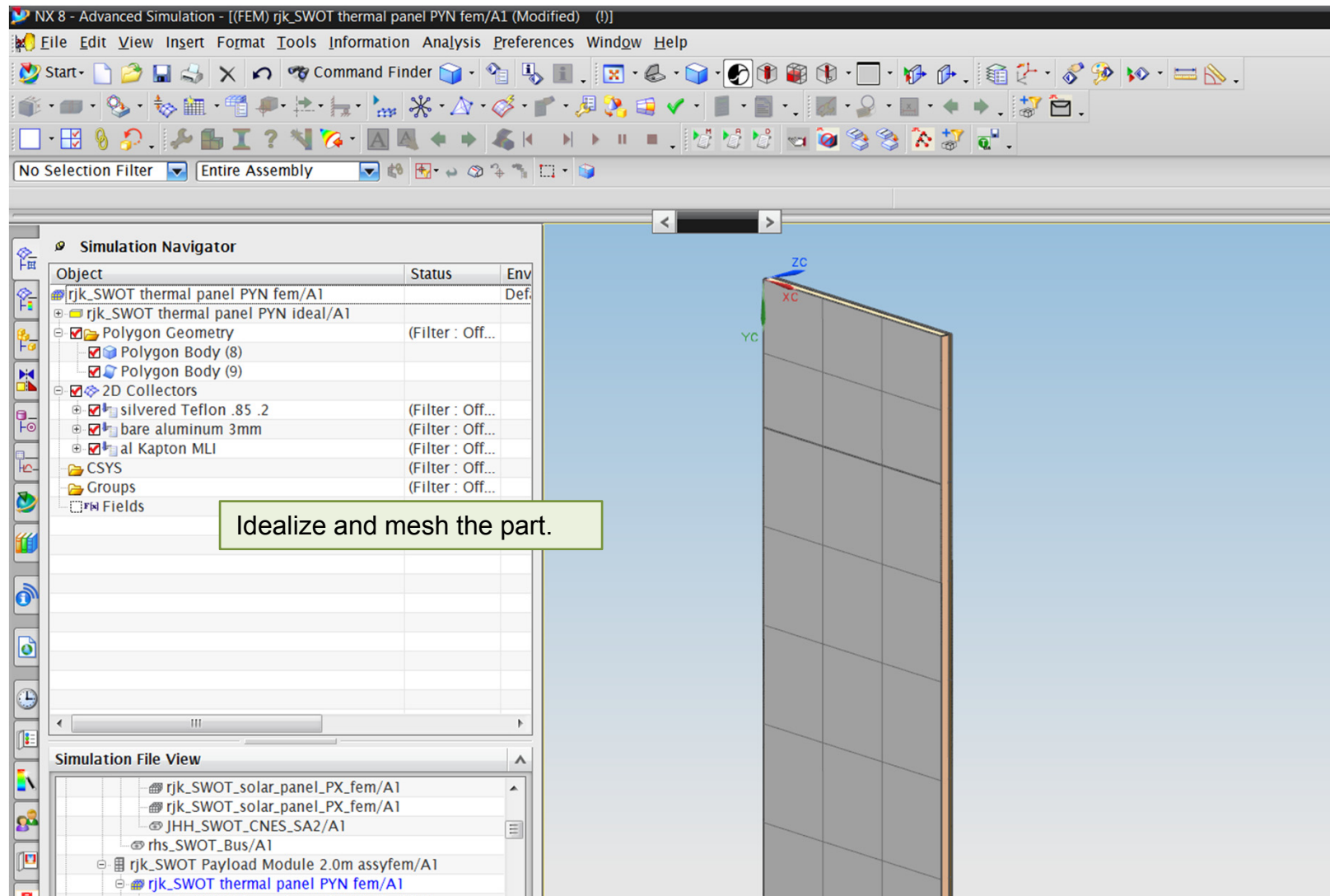
The screenshot shows the NX 8 - Advanced Simulation software interface. The title bar indicates the file is '[rhs\_SWOT\_Thermal\_Panel\_+Y\_1.425m/A1-SWOT Thermal Panel +Y 1.425m (Read Only) (I)]'. The menu bar includes File, Edit, View, Insert, Format, Tools, Assemblies, Information, Analysis, Preferences, Window, and Help. The toolbar contains various icons for file operations, modeling, and simulation. The Simulation Navigator panel on the left shows a table with columns for Object, Status, and Env. The object 'rhs\_SWOT\_Thermal\_Panel\_+Y\_1.425m/A1' is selected, and a context menu is open with options: 'New FEM...', 'New FEM and Simulation...', and 'New Assembly FEM...'. The Simulation File View panel at the bottom shows a tree structure of simulation sessions and assemblies. A yellow callout box with a green arrow pointing to the 'New FEM and Simulation...' option contains the following text:

Switch to Advanced Simulation and go to the Simulation Navigator. Then create a new FEM and Sim. For an orbital thermal model, choose NX Space Systems Thermal as the solver.

Tip: Be careful with your file names. You will have an easier time finding things if you start with the part name and add the CAE terms "ideal", "fem", "assyfem", "sim", or "assysim". Using the existing part name helps later when you map part FEMs to assembly FEMs. CAE terms in the name help in the Simulation File View where you won't see file extensions. Also note that names in Teamcenter cannot be re-used.



# Idealize and Mesh





# Open the Sim



Simulation File View

- rjk\_SWOT\_solar\_panel\_PX\_fem/A1
- rjk\_SWOT\_solar\_panel\_PX\_fem/A1
- JHH\_SWOT\_CNES\_SA2/A1
- rhs\_SWOT\_Bus/A1
- rjk\_SWOT Payload Module 2.0m assyfem/A1
  - rjk\_SWOT thermal panel PY fem/A1**
  - rhs\_SWOT\_therma
  - rjk\_SWOT thermal pane
  - rjk\_SWOT HVPS pallet
  - rjk\_SWOT panel PY 2.0
  - rjk\_swot3 LHP cond2 assyfem/A1
  - rjk\_swot3 cond hpipe PY fem/A1
  - rhs\_swot3\_LHP\_condensor2/A1
  - rjk\_SWOT\_feed\_PY\_upper\_fem/A1
  - rjk\_SWOT\_feed\_PY\_lower\_fem/A1
  - rjk\_SWOT\_feed\_NY\_top\_fem/A1
  - rjk\_SWOT Feed -Y lower fem/A1

Context Menu:

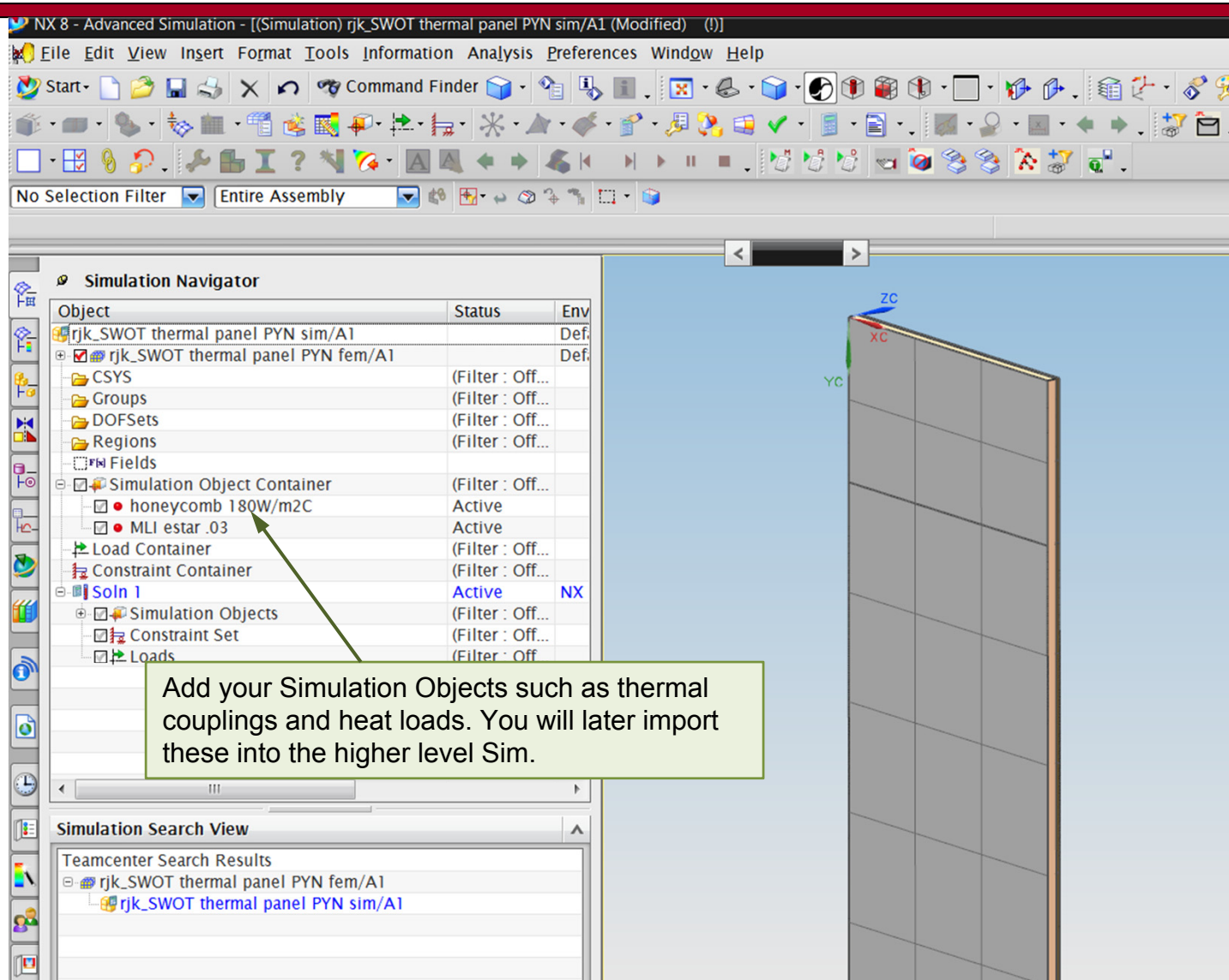
- New Simulation...
- Save
- Close
- Find CAE Items

Switch to the Sim.  
Tip: If you already have a Sim, you can quickly open it by going to the Simulation file View, right-clicking the FEM, and clicking Find CAE Items. This switches you to the Search Results mode where you can double-click the Sim. You can switch back to the Session View with a right-click on the Search Results.



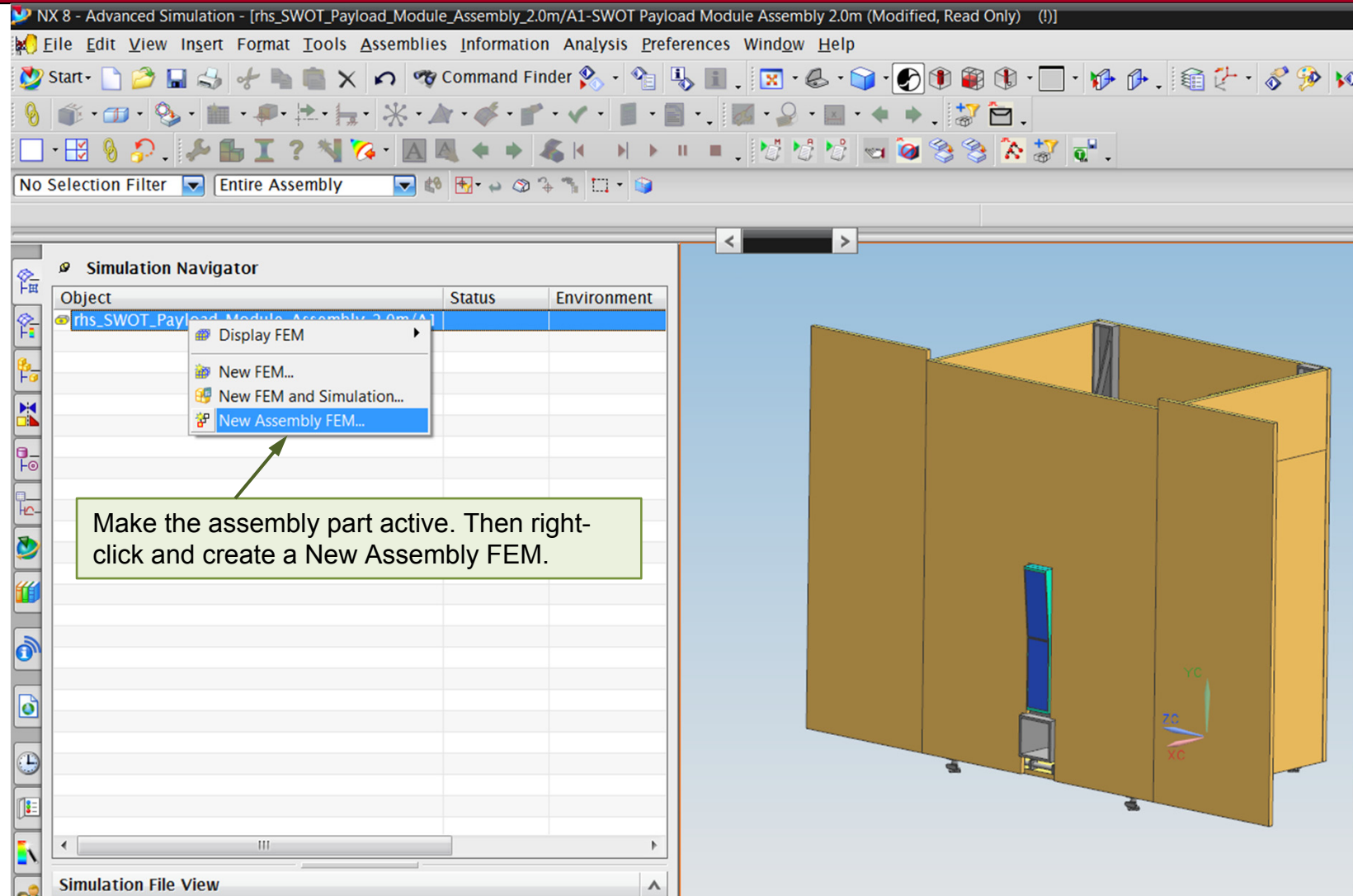


# Add Simulation Objects





# Create a New Assembly FEM





# Map the Part FEM



NX 8 - Advanced Simulation - [(Assembly FEM) rjk\_SWOT Payload Module 2.0m assyfer/A1 (Modified) (!)]

File Edit View Insert Format Tools Assemblies Information Analysis Preferences Window Help

Start Command Finder

No Selection Filter Entire Assembly

**Simulation Navigator**

Object	Status	Environment
rjk_SWOT Payload Module 2.0m assyfer/A1		Default: NX
rhs_SWOT_Payload_Module_Assembly_2.0...		
rhs_SWOT_thermal_panel_+y/A1	Ignored	
rhs_SWOT_thermal_panel_+y/A1		
rhs_SWOT_Comm_Ant/A1		
rhs_SWOT_Poseidon_Bracket_2/A		
DRW_DORIS_ANTENNA_FOV/A1		
DRW_LASER_REFLECTOR_FOV/A		
rhs_SWOT_Panel_Bracket2/A1	Ignored	
rhs_SWOT_Panel_Bracket2/A1	Ignored	
rhs_SWOT_Panel_Bracket1/A1	Ignored	
rhs_SWOT_Panel_Bracket1/A1	Ignored	
rhs_SWOT_Panel_Bracket/A1	Ignored	
rhs_SWOT_Panel_Z2_2.0m/A1	Ignored	
rhs_SWOT_RUAG_x-band_LGA/A1	Ignored	
rhs_SWOT_RUAG_x-band_LGA/A1	Ignored	
rhs_SWOT_Antenna_Bracket_2/A1	Ignored	
rhs_SWOT_Antenna_Bracket/A1	Ignored	
rhs_SWOT_Panel_Bracket/A1	Ignored	
rhs_SWOT_panel_+z2_2.0m/A1	Ignored	
rhs_SWOT_panel+z_2.0m/A1	Ignored	
rhs_SWOT_Payload_Structure_Assembly_...	Ignored	

Map the part FEM onto the assembly FEM by right-clicking on the part and selecting Map Existing.



# Map All Part FEMs



**Simulation Navigator**

Object	Status	Env
rjk_SWOT Payload Module 2.0m assyfer/A1		
rhs_SWOT_Payload_Module_Assembly_2.0...		
rhs_SWOT_thermal_panel_+y/A1	rjk_SWOT t...	
rhs_SWOT_thermal_panel_+y/A1	rjk_SWOT t...	
rhs_SWOT_Comm_Ant/A1	SWOT Co...	
rhs_SWOT_Poseidon_Bracket_2/A1	Ignored	
DRW_DORIS_ANTENNA_FOV/A1	Ignored	
DRW_LASER_REFLECTOR_FOV/A1	Ignored	
rhs_SWOT_Panel_Bracket2/A1	Ignored	
rhs_SWOT_Panel_Bracket2/A1	Ignored	
rhs_SWOT_Panel_Bracket1/A1	Ignored	
rhs_SWOT_Panel_Bracket1/A1	Ignored	
rhs_SWOT_Panel_Bracket/A1	Ignored	
rhs_SWOT_Panel_Z2_2.0m/A1	rjk_SWOT ...	
rhs_SWOT_RUAG_x-band_LGA/A1	Ignored	
rhs_SWOT_RUAG_x-band_LGA/A1	Ignored	
rhs_SWOT_Antenna_Bracket_2/A1	Ignored	
rhs_SWOT_Antenna_Bracket/A1	Ignored	
rhs_SWOT_Panel_Bracket/A1	Ignored	
rhs_SWOT_panel+z2_2.0m/A1	rjk_SWOT ...	
rhs_SWOT_panel+z_2.0m/A1	rjk_SWOT ...	
rhs_SWOT_Payload_Structure_Assembly...	rik_SWOT ...	

**Simulation File View**

Session

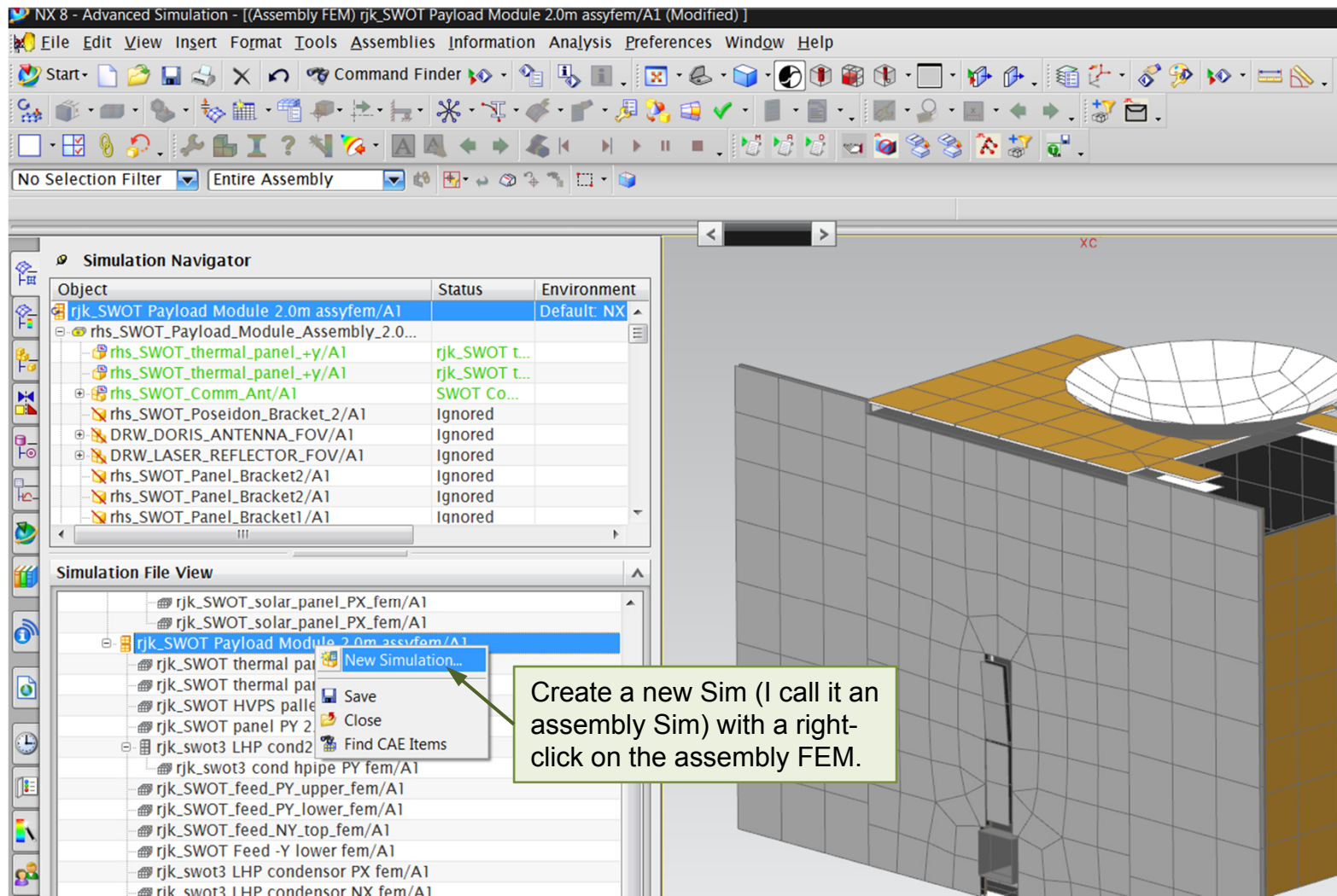
- rjk\_SWOT\_10m\_baseline\_assysim/A1
  - rjk\_SWOT\_10m\_config\_assysim/A1
    - rjk\_SWOT Refl Array 10m NY assysim/A1
      - rjk\_SWOT RA 10m Boom Inner NY fem/A1
      - rhs\_SWOT\_Reflector\_Array\_10m/A1

**Tip:**  
Right-click the FEM, go to the Label Manager, and resolve the label conflicts. The orbit plotter and thermal couplings will not work with label conflicts.





# Create an Assembly Sim





# Import Simulation Entities



The screenshot displays the 'Simulation Navigator' panel on the left, which lists various simulation objects and their environments. A context menu is open over the 'rjk\_SWOT thermal panel PYP fem/A1' entry, with 'Import Simulation Entities' highlighted. A green callout box explains the process: 'Import the thermal couplings from the part Sims by right-clicking the part FEM and choosing Import Simulation Entities.' The 3D model on the right shows a complex structure with a yellow grid on top and a grey grid on the side, with a 'XC' label in the top right corner.

Object	Status	Environment
rjk_SWOT Payload Module 2.0m assysim/A1		Default: NX
[-] rjk_SWOT Payload Module 2.0m assyfem...	Update Pe...	Default: NX
[-] rhs_SWOT_Payload_Module_Assembly_2....		
[-] SWOT Comm Ant assyfem/A1		Default: NX
[-] SWOT Panel +Z fem/A1		Default: NX
[-] rjk_SWOT panel -Z fem/A1		Default: NX
[-] rjk_SWOT_panel -Y 2.0m fem/A1		Default: NX
[-] rjk_SWOT Payload Structure assyfem/A1		Default: NX
[-] rjk_SWOT panel PX 2 2m fem/A1		Default: NX
[-] rjk_SWOT panel NX 1 2m fem/A1		Default: NX
[-] rjk_SWOT panel PX 1 2m fem/A1		Default: NX
[-] rjk_SWOT panel NX 2 2m fem/A1		Default: NX
[-] rjk_swot3 pallet NX fem/A1		Default: NX
[-] rjk_swot3 pallet PX fem/A1		Default: NX
[-] rjk_swot3 LHP condensor PY fem/A1		Default: NX
[-] rjk_swot3 LHP condensor NX fem/A1		Default: NX
[-] rjk_swot3 LHP condensor PX fem/A1		Default: NX
[-] rjk_SWOT Feed -Y lower fem/A1		
[-] rjk_SWOT_feed_NY_top_fem/A1		
[-] rjk_SWOT_feed_PY_lower_fem/A1		
[-] rjk_SWOT_feed_PY_upper_fem/A1		
[-] rjk_swot3 LHP cond2 assyfem/A1		
[-] rjk_SWOT panel PY 2.0m fem/A1		
[-] rjk_SWOT HVPS pallet fem/A1		
[-] rjk_SWOT thermal panel PYP fem/A1		Default: NX
[-] rjk_SWOT thermal panel PYP fem/A1		Default: NX
CSYS		
Groups		
DOESate		

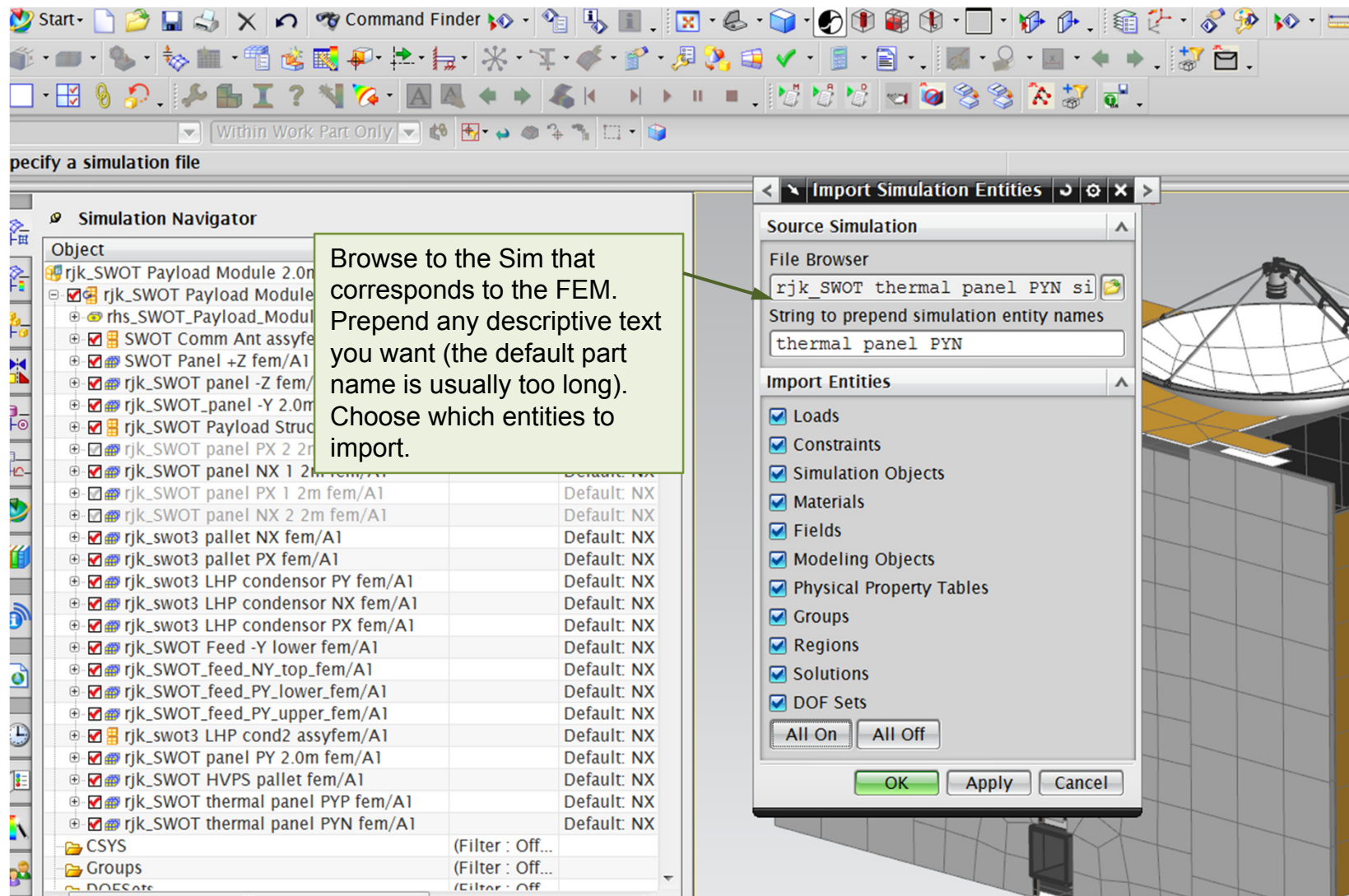
Simulation Search View

Teamcenter Search Results

- [-] rjk\_SWOT Payload Module 2.0m assyfem/A1
- [-] rjk\_SWOT Payload Module 2.0m assysim/A1



# Choose Names and Entities







# Map Remaining Assembly and Part FEMs



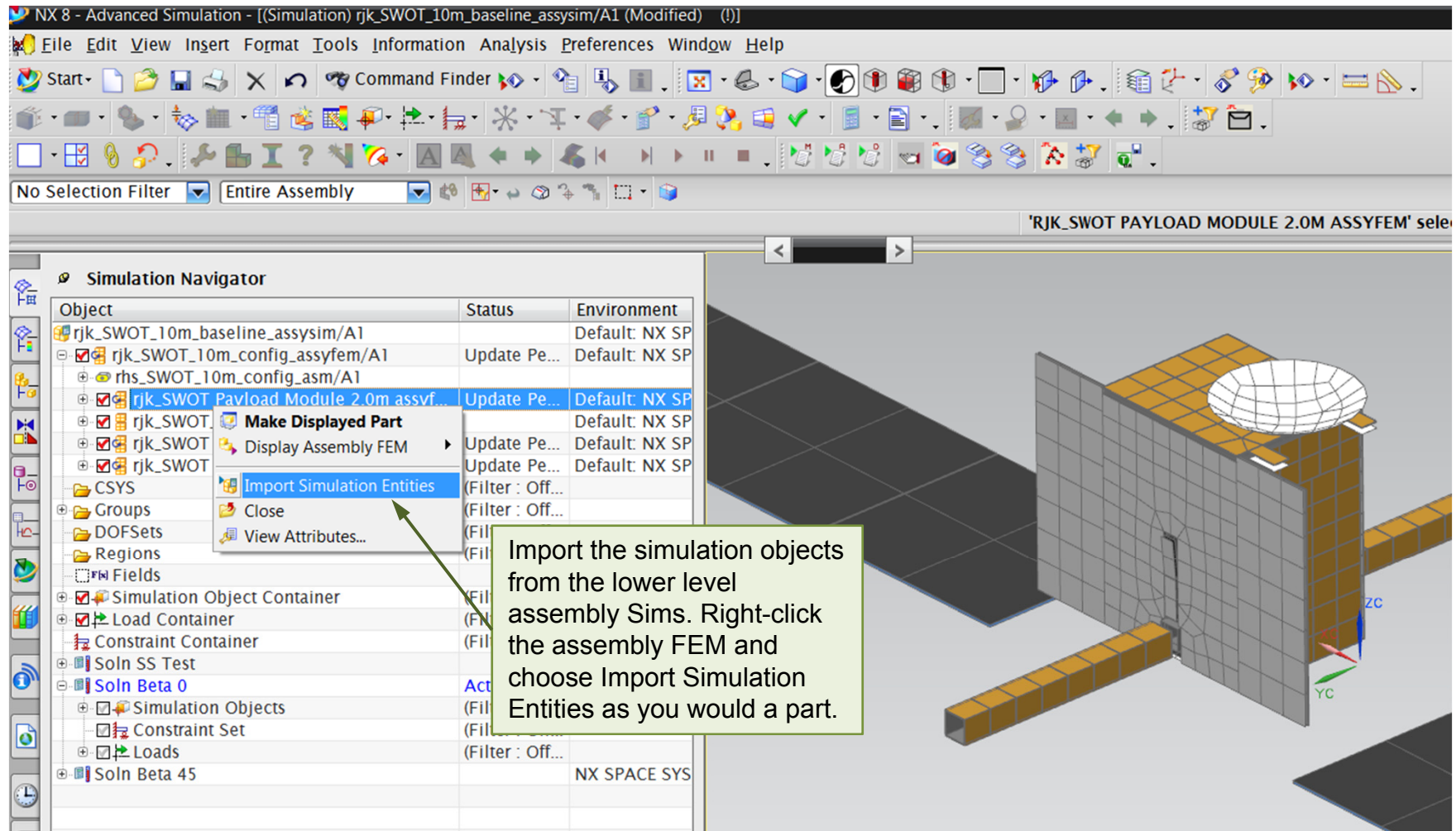
The screenshot shows the NX 8 Advanced Simulation interface. The main window displays a 3D model of a satellite assembly with a central body and two long, thin solar panel arms. A coordinate system (X, Y, Z) is visible at the bottom right of the model. The Simulation Navigator table on the left lists the following objects:

Object	Status	Environment
rjk_SWOT_10m_config_assyfem/A1		Default: NX SP
rhs_SWOT_10m_config_asm/A1		
<input checked="" type="checkbox"/> rjk_SWOT Payload Module 2.0m assyfem...	Update Pe...	Default: NX SP
<input checked="" type="checkbox"/> rjk_SWOT_Bus_assyfem/A1		Default: NX SP
<input checked="" type="checkbox"/> rjk_SWOT Refl Array 10m +Y assyfem/A1	Update Pe...	Default: NX SP
<input checked="" type="checkbox"/> rjk_SWOT Refl Array 10m NY assyfem/A1	Update Pe...	Default: NX SP
CSYS	(Filter : Off...	
Groups	(Filter : Off...	
Fields		

Work your way up to the top-level assembly FEM by mapping lower level assembly FEMs. You can map any combination of part FEMs and assembly FEMs.



# Import Entities from Sub-Assemblies





# Prepare External Radiation



The screenshot displays the NASA STS software interface. The 'Simulation Navigator' tree on the left shows a hierarchy of objects and groups. The 'External radiation' dialog box is open on the right, showing settings for 'Top Side Region' and 'Bottom Side Region'. A green callout box points to the 'External radiation' group in the tree and the 'External radiation top' and 'External radiation bottom' group references in the dialog box.

**Simulation Navigator**

Object	Status	Environment
[-] rjk_SWOT_10m_config_assyfem/A1	Update Pe...	Default: NX
[-] rhs_SWOT_10m_config_asm/A1		
[-] rjk_SWOT Payload Module 2.0m assyfem/A1	Update Pe...	Default: NX
[-] rjk_SWOT_Bus_assyfem/A1		Default: NX
[-] rjk_SWOT Refl Array 10m +Y assyfem/...	Update Pe...	Default: NX
[-] rjk_SWOT Refl Array 10m NY assyfem/...	Update Pe...	Default: NX
[-] CSYS	(Filter : Off...	
[-] Groups	(Filter : Off...	
1 - External radiation top		
2 - External radiation bottom		
3 - Elements for plotting		
4 - Surfaces for orbital plotting		
5 - All elements		
6 - Baseline elements		
[-] DOFSets		
[-] Regions		
[-] Fields		
[-] Simulation Object Container		
[-] Orbital Heating Beta 0	Active	
[-] External radiation	Active	
[-] Bus_SA_NX_solar_array_Honeycomb 1...	Active	
[-] Bus_SA_NX_solar_array_Honeycomb 1...	Active	
[-] Bus_SA_NX_solar_array_Honeycomb 1...	Active	
[-] Bus_SA_NX_solar_array_Honeycomb 1...	Active	

**External radiation**

Name: External radiation

Top Side Region

- ☒ Group Reference: External radiation top
- Filter Type: Polygon Face
- ☒ Select Object (40)
- Excluded

Bottom Side Region

- ☒ Group Reference: External radiation bottom
- Filter Type: Polygon Face
- ☒ Select Object (2)
- Excluded

Parameters

- ☒ Include Radiative Environment
- Calculation Method: Hemicube Rendering
- View Factor Accuracy: Medium (128 x 128)
- Element Subdivision: 3
- ☐ Elements not Part of this Enclosure Can Shadow

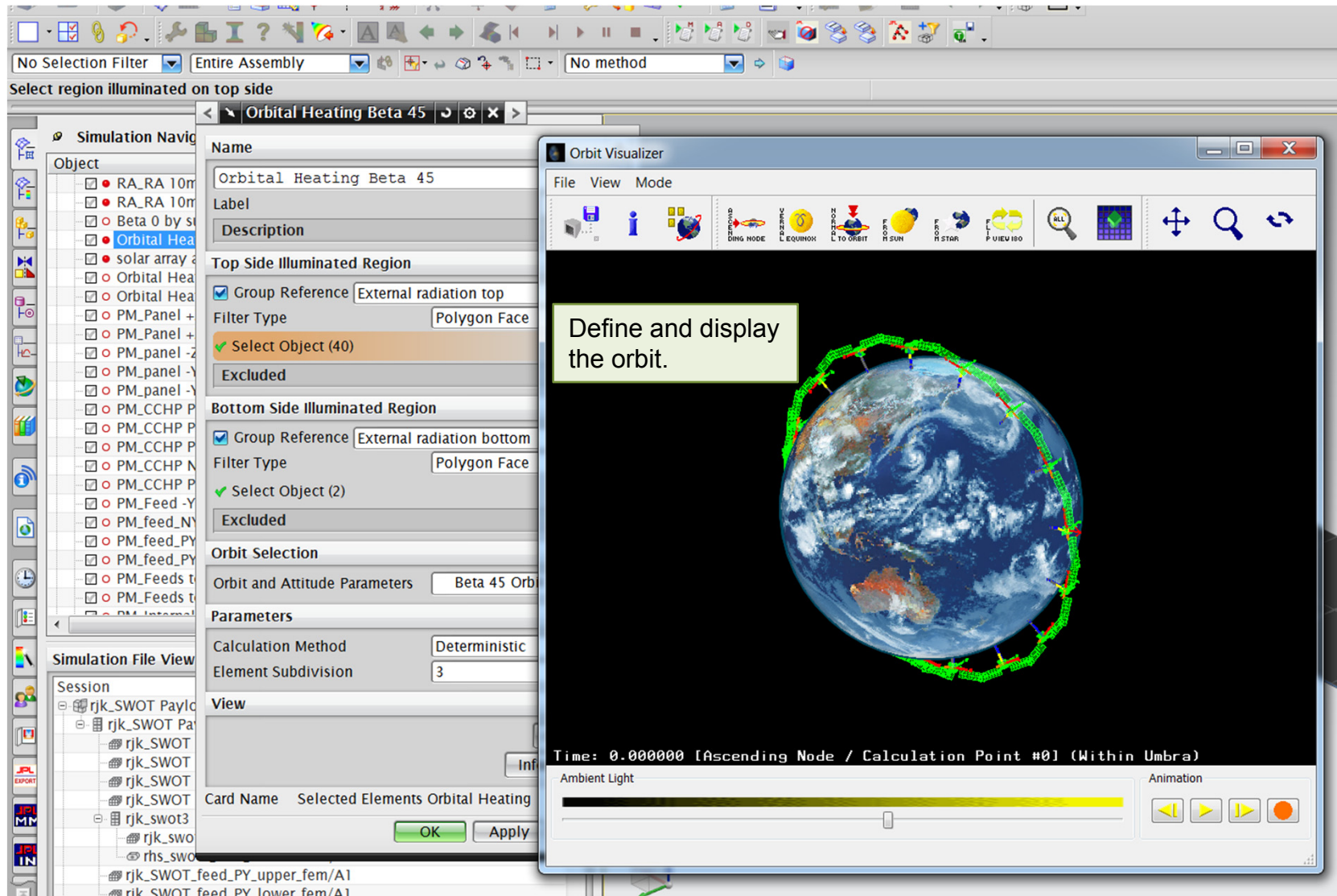
Card Name: Enclosure Radiation

OK Apply Cancel

Create groups of external surfaces to use for both radiation and orbital heating.



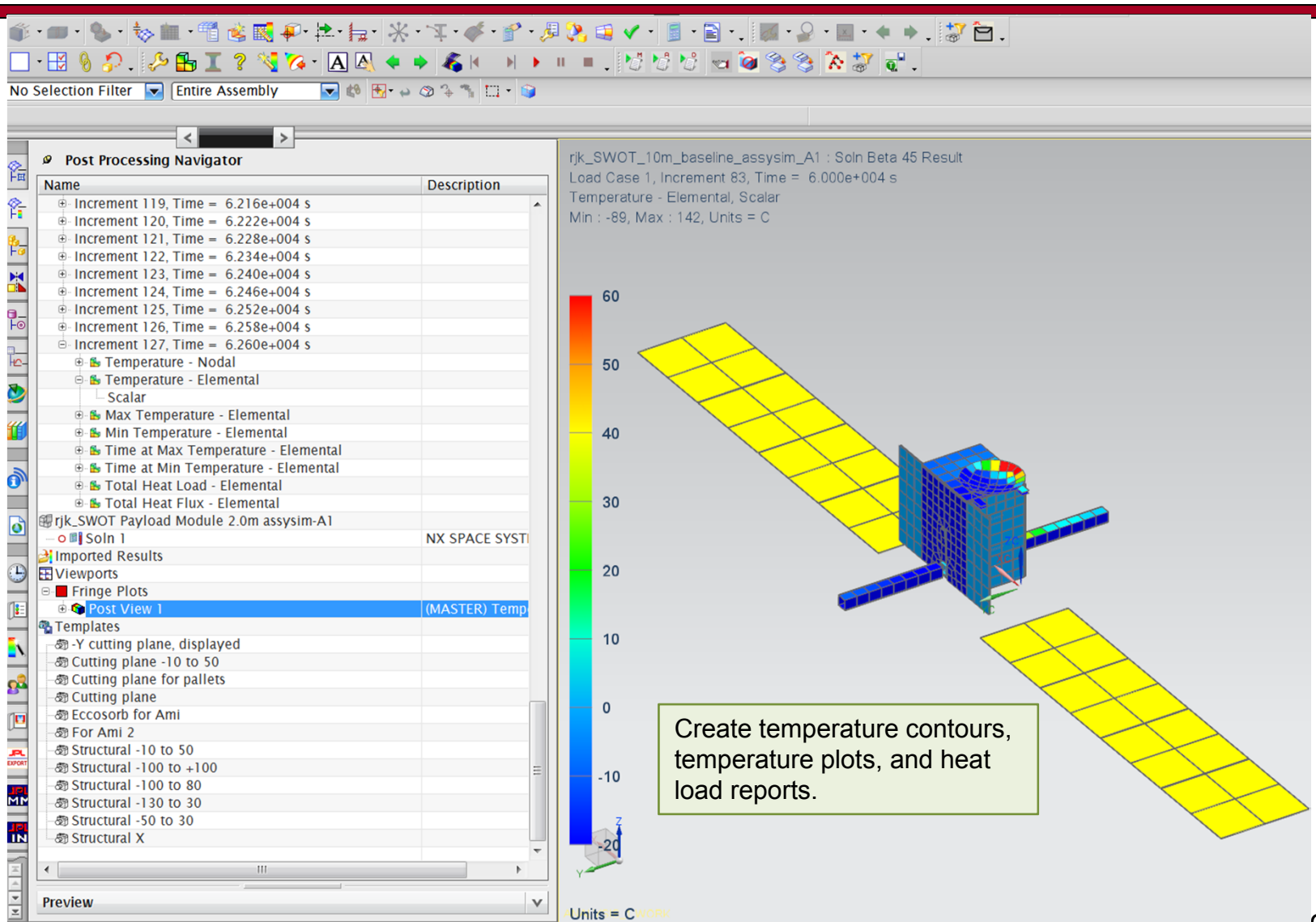
# Prepare Orbital Heating







# Solve and Examine Results







# Summary



- 
- You can work completely within Teamcenter to build and solve an orbital thermal model.
  - Your model will have a one-to-one correspondence to the parts and assemblies of the CAD model.
  - You can input thermal couplings and loads at the part and assembly levels.
  - Orbital thermal analysis is performed with Space Systems Thermal.



## Where does this lead?



- 
- NX parts are associated to the thermal model. An update to an NX part propagates automatically, with your permission, to the top level assembly FEM.
    - This will allow you to quickly assess the impact of design changes
  - The thermal analysis will be linked to the mechanical parts.
  - Assembly FEMs are modular.
    - You should be able to divide a spacecraft among several engineers for simultaneous analysis.
  - This leads to concurrent engineering.